STATEMENT OF PROJECT OBJECTIVES

DE-FG26-06NT42723

Development and Demonstration of a Modeling Framework for Assessing the Efficacy of Using Mine Water for Thermoelectric Power Generation

A. Objectives

The purpose of this study is to develop and demonstrate a framework for assessing the costs, technical and regulatory aspects and environmental benefits of using mine water for thermo-electric power generation. The framework will provide a systematic process for evaluating the hydrologic, chemical, engineering and environmental factors to be considered and evaluated in using mine water as an alternative to traditional freshwater supply. Development and demonstration of the framework will involve the following activities:

- A field investigation and case study will be conducted for the proposed Beech Hollow Power Plant located in Champion Pennsylvania. The field study, based on previous mine pool research conducted by the National Mine Land Reclamation Center (NMLRC), will identify mine water sources sufficient to reliably supply the 2,000 to 3,000 gpm power plant water requirement.
- A water collection, transportation and treatment system will be designed around this facility.
- Utilizing this case study, a computer based design aid will be developed utilizing the water collection and handling principles derived during the field investigation, and from previous studies of mine water and power plant cooling including information obtained from other power plants using mine water. The cost of using mine water for plant cooling or other plant uses will be compared to the cost of using alternate water supplies, including surface water and public water (as currently contemplated in the Beech Hollow power plant design) and river water for other power plant sites. In addition, the potential environmental improvements resulting from the utilization of mine water that is currently contaminating area streams will be documented.

Background

A 300 megawatt power plant has been proposed to burn coal refuse from the Champion coal refuse pile, which is the largest coal waste pile in Western Pennsylvania. Current plans call for the use of public water at the rate of between 2,000 and 3,000 gallons per minute. Numerous surface and underground mines exist within six miles of the proposed power plant. These mines are both above drainage and below drainage thus providing a wide diversity of water acquisition problems and opportunities. Some mine discharges in this area have been previously mapped under NETL Project DE-AM26-99FT40463 also known as NMLRC project WV-173. Other discharges, particularly the above drainage discharges in Robinson Run and the north branch of Robinson Run, were not mapped as part of this previous project.

Several thermoelectric plants in Eastern Pennsylvania utilize mine waters (from coal and non-coal mines) in their operations. These uses are for non-contact cooling water, coal combustion byproduct conditioning , and for flow augmentation (allowing a power plant to withdraw water from surface water sources while using water pumped and/or discharged from mine to augment stream flow). Because these plants are located in the anthracite coal region the raw mine water quality is generally acceptable for cooling use and stream flow augmentation with minimal treatment. This is in contrast with the Beech Hollow plant that is located in the bituminous coal region where mine water is of poorer quality requiring additional treatment for surface discharge. In addition, this project will consider the use of ambient mine water temperature to enhance plant thermal efficiency. Also, the anthracite mines that are used in northeastern Pennsylvania are very deep, steeply pitched, with very thick seams resulting in large, deep, and continuous mine voids that can supply the needs of a typical FBC plant from a single mine with minimal collection systems. The Pittsburgh coal seam in the vicinity of the Champion refuse pile is, on the other hand, nearly horizontal, largely above drainage with many relative small mines. In contrasting our results with those of the anthracite region applications, our model will consider not only the water treatment costs but also the costs of accessing, balancing and transporting multiple sources to constitute an adequate and continuous water supply to the power plant.

B. Scope of Project

The mine discharges in the vicinity of the proposed power plant will be located, sampled and their flow will be determined under wet and dry weather conditions. Mine mapping will be located, scanned, and geo-referenced to identify the area that is contributing to the discharge. Water elevations in selected mine pools will be monitored. Continuous discharge flow monitoring will be conducted at two or more sites to establish seasonal variations. These data will be integrated with plant water requirements and environmental considerations to design a mine water collection, treatment, and delivery system to meet the power plant water needs under all weather conditions.

Utilizing the data and the decision making process derived in the previous task, as well as any appropriate data and information obtained from other thermoelectric plants utilizing mine water, a computer based design aid will be developed for estimating the cost of water acquisition and delivery to the power plant. Where appropriate a decision tree will be incorporated into the design aid package. Unit cost data will be obtained for use in calculating the cost of water acquisition, treatment and delivery. These data will be incorporated into the design aid. Once completed, the design aid will be compared to the actual design cost estimate to determine the effectiveness of the computer-based system.

Data obtained in the initial mine discharge assessment will be combined with available stream flow and water quality data from the receiving streams in the area. Reductions in acid and metal loads due to the use of mine water by the power plant will be calculated and potential environmental improvement will be estimated.

C. Tasks to Be Performed

Task 1. Field Investigation

Task 1-1 Identify mine water sources.

Discharges of mine water will be identified within a distance of 6 miles from the proposed plant site. If the power plant water needs can be achieved in a smaller area, the study area will be reduced, if more area is required, the study area will be increased. Water flow and water quality will be measured under high and low flow conditions. Field reconnaissance will be combined with records from PA Department of Environmental Protection, as well as data from area mining companies. Three monitoring wells will be drilled into identified mine pools to determine reservoir and water level fluctuation.

Task 1-2 Quantify volume and quality of mine water.

Based on volume and proximity at least two mine discharges identified in task 1-1 will be selected for additional monitoring. It is anticipated that one discharge will be from a below drainage underground mine, the second discharge will be from an above drainage underground mine. These two discharges will be equipped with a primary water flow measuring device such as a weir or a flume. Water flow will be recorded using a recording pressure transducer. The water level data will be recorded on an hourly basis that will be collected on a monthly basis and converted into flow data. These data will be evaluated in comparison to actual and historical precipitation data as recorded at the near-by Pittsburgh International Airport to normalize our field results against historic trends. Water quality analyses will be conducted on a monthly basis.

Task 1-3 Create GIS mapping.

Several discharges will be selected from those identified in task 1-1 where there is more than sufficient flow to meet the power plant water requirements and which minimize piping requirements. High-resolution mine maps will be sought for these mines so that the flow of water within the mines can be assessed. These maps will be scanned, geo-referenced, and used in a geographic information system. If possible, the underground mine data will be used to determine if alternate mine discharge points should be developed for the benefit of the project. The underground maps will also be used to determine the area of contribution to the discharge point.

Task 1-4 Select mine water sources.

Data from Tasks 1-2, and 1-3 will be combined to establish precipitation/mine discharge relationships that can be used to project the low flow mine discharges with a recurrence interval of 1 in 10 years. In addition, mine water treatment requirements will be assessed to meet power plant water quality needs. Based on this analysis the final mine discharges will be selected for engineering analysis.

Task 1-5 Design collection, piping and treatment system.

A water collection, piping and treatment and sludge disposal system will be designed to gather the water from the various sources, transport it and treat it at the power plant site. WVU personnel will work interactively with the power plant design team to integrate mine water use into the power plant design. This design will be for cost analysis only; no construction drawings will be generated. Capital and operating costs will be identified for each of the system components. These costs will be combined to generate a total capital and operating cost for the mine water system.

Task 1-6 Evaluate costs of alternatives.

The cost of other water sources will be identified; specifically, the cost of public water and the cost of river water. These costs will be compared to the cost of treated mine water to determine the potential savings. Other potential cost factors such as withdrawal permitting and plant post closure liability will be evaluated.

<u>Task 2. Computer based design aid</u>

Task 2-1 Develop general information module.

Visual basic will be used to create a general information module. This module will contain site and owner information as well as anticipated design data for a range of power plant water needs. In addition the module will determine if the mine water is to be used solely as makeup water or whether thermal advantage is to be derived from the water as well. All inputs will default to typical design conditions and costs but provision will be made for the user to enter plant specific inputs.

An attempt will be made to include applicable information and data regarding mine water use by plants in the anthracite region that are currently using mine water. The plant owners and operators will be identified through contacts with the Commonwealth of Pennsylvania, State Water Resources Planning Committee, the Susquehanna River Basin Commission (SRBC), and the Delaware River Basin Commission (DRBC). Individual plant owner/operators will be contacted and requested to provide details regarding the rationale/drivers for utilizing mine water, mine water volume and quality used in various operations, delivery, piping and treatment configurations and designs and the economics of these projects.

Task 2-2 Develop water source module.

Visual Basic will be used to create a water source module. This module will allow the user to input mine discharge flow, water quality, pipeline distance from the source to the treatment plant, elevation of mine water, elevation of mine water pump, elevation of treatment plant, and maximum elevation of the pipeline. Based on these data the program will recommend three different pipeline diameters and estimate fully installed cost for each option. The program will also evaluate the low flow discharge volume for above drainage mines and the sustainable yield for below drainage underground mines. It is anticipated that multiple mine water sources may be needed for any given project; consequently the program will be designed to accept multiple water source inputs

Task 2-3 Develop water treatment module.

Visual Basic will be used to create a water treatment module. Due to the volume of water required for power plant cooling and the cost of available reagents this module will utilize hydrated lime as the primary neutralizing reagent with either air or hydrogen peroxide as the oxidant. The treatment facility will be designed to either minimize or not minimize mine water temperature depending on the intended use of the water in the power plant. Post-treatment water quality will be estimated based on mineral phase equilibrium equations. Plant equipment sizing will be determined automatically based on the water treatment volume and the raw water chemistry.

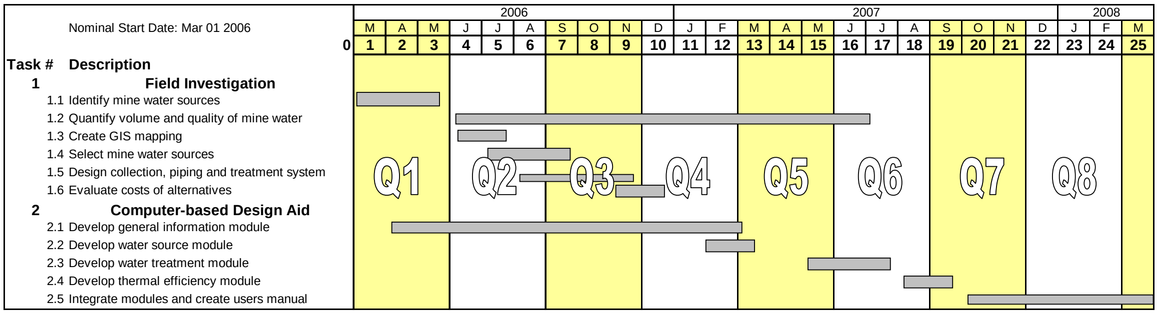
Task 2-4 Develop thermal efficiency module.

Using mine pool water will likely lower the nominal summer water temperature entering the plant. For those power plants that elect to integrate this effect into their power plant design, a Visual Basic module will be developed that evaluates both capital and operational cost savings resulting from using mine water of a constant temperature. This module will calculate the reduction in equipment size, and associated cost reduction, that can be expected with lower temperature makeup water.

Task 2-5 Integrate modules and create users manual.

All of the modules will be integrated into a seamless self-explanatory computer design aid. The design aid will be tested to verify that all of the components are functioning correctly and in unison with each other. A user’s manual will be developed that includes the methodology used in the computer design aid as well as the base cost data used in the simulation.

Project Schedule



D. Critical Path Project Milestones (Milestone Plan/Status)

A Milestone Plan will be used as a planning tool to establish the time schedule for accomplishing the planned work. The Milestone Plan serves as the baseline for tracking performance of the project and identifies critical path project milestones (no less than 2 per calendar year) for the entire project. The initial Milestone Plan is listed below. Any changes required as the project advances will be submitted to the DOE COR for review and approval.

Milestone	Planned Completion Date (months after project start)
Identify mine water sources.	3
Create GIS mapping	6
Design collection, piping and treatment system.	9
Evaluate costs of alternatives	12
Develop water source module	15
Develop water treatment module	18
Develop thermal efficiency module	21
Integrate modules and create users manual	24

During project performance, the Recipient will report the Milestone Status as part of the required quarterly Progress Report as prescribed under Attachment 4, Reporting Requirements Checklist, Section 4.A.7-Progress Report. The Milestone Status will present actual performance in comparison with Milestone Plan, and include:

(1) the actual status and progress of the project,
(2) specific progress made toward achieving the project's critical path milestones, and,
(3) any proposed changes in the projects schedule required to complete critical path milestones.

E. Deliverables

Kick off meeting

Within 90 days after the project start date, a project kick-off meeting will be held with project researchers, the DOE-Program manager, and project participants. A description of the work to be performed, how that work is to be performed, and schedule of performance will be presented.

Topical Report - Task 1

A report will be prepared describing the factors that must be considered in evaluating mine water use for power plant cooling and operational needs. Systematic methodologies for identifying sources and establishing available mine water volumes and chemistries will be developed along with approaches for projecting environmental benefits of mine water use. A description of the results of the field investigation and water collection system design will be included as an example of application . The Beech Hollow example will include water volume and water quality analysis from the mine water discharge sites identified during the study. A map will be provided showing the location of all mine discharges and sampling points found during the study. The map will also include the location of the sites that have been selected to be the water source for the power plant and the location of the proposed water collection and treatment system. The report will include a narrative analysis of the data collected and tables showing the cost estimates for the proposed water collection and delivery system. The report will also include an assessment of the cost for the providing municipal and river water to the proposed plant. Environmental benefits will be estimated based on AMD loading reductions and subsequent physical, chemical and biological improvements in streams receiving mine drainage.

Semi Annual Briefings

A semi-annual briefing will be held 6-7 months after the start of the project with project researchers, the NETL Program manager, and project participants. A status report on progress to date will be presented. A time for discussion and questions will be included. Subsequent semi-annual meetings will be scheduled with the NETL Program Manager in 12-13 months and 18-19 months after the start of the project.

Design Aid - Task 2

The deliverables for this task include the operational design aid in visual basic. The design aid will be easily installable on computers with minimum Pentium 90 MHz CPU and 48 megabytes of available memory and a minimum of 32 megabytes of RAM megabytes of memory. These system requirements may be increased as development of the design aid progresses. The design aid will be provided in CD form and will be available for download on the West Virginia Water Research Institute web site. A paper copy of the user's manual will be provided and the manual will also be available on the web site.

Final Project Meeting

A final project meeting will be held with project researchers, the DOE-Program manager, and project participants 24-25 months after the start of the project. A report on the final project work will be presented. A time for discussion and questions will be included.